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PICATINNY ARSENAL
TECHNICAL DIVISION

TECHNICAL REPORT

SUBJECT: LONG RANGE RESEARCH LEADING TO THE DEVELOPMENT OF SUPERIOR PROPELLANTS

Coatings for Small Arms Powders - Substitutes for DNT

PROJECT NO. TA1-5006B **REPORT NO.** 1

PREPARED BY: H. A. Aaronson **DATE** 30 September 1951

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Prepared by:

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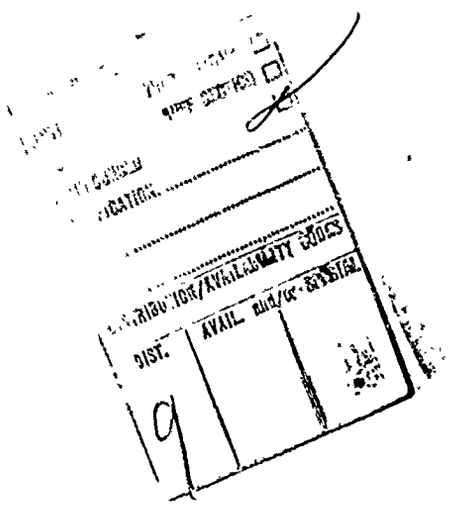
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Project No:	TA1-5006B
DOA Priority Designation:	2A
Project Title:	Long Range Research Leading to the Development of Superior Propellants - Coatings for Small Arms Powders - Substitutes for DNT

OBJECT

To develop a higher melting substitute for DNT for coating propellent powders for small arms.

SUMMARY

As a result of the higher skin and body temperatures developed during the flight of modern high speed military planes, it is desirable to develop for small arms powders a deterrent coating having an appreciably higher melting point than the current standard DNT (S.P. 68° ± 2.5°C). A study was undertaken to find such a substitute for caliber .50 (Type I) powder. It was found that powders coated with 6% dinitroanisole (DNA, MP 94.3 - 95.1°C) could be prepared so as to have the required muzzle velocity at a pressure below the maximum allowable.

Since it is fully expected that caliber .30 powder can also be coated with DNA to yield satisfactory ballistics at ambient temperatures, no laboratory work was done on this caliber powder.

Further work on a semi-plant scale to check the laboratory results on the suitability of DNA as a deterrent coating for small arms powders, both .50 and .30 calibers has been initiated.

Consideration of the production of DNA, now not commercially available in any appreciable quantity, indicates a probable cost of approximately $0.40 per pound. Since only 6% of DNA is needed instead of about 9% of DNT, the cost of coating the powder should not be much greater.

CONCLUSION

Preliminary laboratory experiments and data indicate 2-4 dinitroanisole to be an excellent high-melting substitute for DNT as a deterrent coating for Type I small arms powders.

RECOMMENDATIONS

(1) It is recommended that the experimental, semi-plant scale study of the coating of caliber .50 and caliber .30 powders, now in progress, be expedited in order that standardization of 2-4 dinitroanisole coatings for service use may be made at an early date if laboratory results are substantiated.

(2) Since DNA is now produced commercially only on a very small scale, it is recommended that a source or sources of supply be established or a laboratory study, based on available procedures, be made to develop a method suitable for large scale manufacture to establish specification requirements.

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INTRODUCTION:

1. In a letter to the Office, Chief of Ordnance from the Air Materiel Command, Wright-Patterson Air Force Base, Dayton, Ohio, dated 28 December 1949 (Ref A), it was stated that aircraft skin temperatures reach as high as 200°F (93.3°C) and aircraft body temperatures of 190°F (87.8°C) for short periods of time and that in view of this, " .. it is considered desirable that a research project be undertaken to improve ammunition propellants for safe operation at temperatures of 165°F to 200°F". This Arsenal was directed to study the development of deterrent coating materials for small arms powders with melting points appreciably higher than the current standard material, DNT (Ref B). A program of research on propellent powders, which included the development of high melting substitutes for DNT was outlined in the 1st Indorsement to Ref B. This is the first progress report on this problem and gives the results of the laboratory work to date.

RESULTS:

2. Good coating with practically no clustering was obtained with the coating agents which gelatinized nitrocellulose, i.e., dinitroanisole (DNA), N,N'-diethyl-N-phenylurea, and N-ethyl-N,N'-diphenylurea (See Table II). Difficulty was encountered in getting the desired amount (6 and 8%) of coating with the non-gelatinizing compounds tried, i.e., meta-terphenyl and p, p'-tetramethyldiaminodiphenylmethane. The addition of a number of different wetting agents to the slurries did not improve the application of the coatings.

3. A standard, Type I, caliber .50 powder (See Table I) was prepared and coated with 6% and 8% of 2-4 dinitroanisole, N,N'-diethyl-N-phenylurea, and N-ethyl-N,N' diphenylurea for 20, 40, and 60 minutes total time (See Table II). The two powders coated with DNA gave ballistic results which complied with the requirements of the governing Specification, JAN-P-733 (See Table V). The size of the flash was slightly smaller than was observed with the standard DNT-coated powder. The color of the flash was the same for both types of coating.

4. Both the 100°C Vacuum Stability Test and 134.5°C Heat Test on the DNA-coated powder show somewhat better heat test results than the standard DNT-coated powder (See Table VI). In unfinished surveillance tests at 80°C in progress for 107 days the powders coated with DNA have not yet shown signs of failure.

DISCUSSION OF RESULTS:

5. Small arms powders, i.e., calibers .50 and .30, are prepared as single-perforated grains. When a grain of this type is burned, the outer surface being larger than the inner burns much more rapidly. As a result the burning surface of the grain as a whole progressively decreases, resulting in a degressive powder. Such a powder gives a low muzzle velocity to the projectile. Because

DISCUSSION OF RESULTS: (contd)

of the small size of the grains, this defect cannot be overcome to any appreciable extent, by increasing the size of the perforation. However, by adding a deterrent coating, which is also a solvent for the nitrocellulose, a gelatinization gradient can be established which decreases from the burning surfaces to the interior of the grain. This will result in an increased rate of burning as combustion proceeds, producing a progressive powder, and one which gives the projectile a much higher velocity than can be obtained with a degressive powder. A similar result can be accomplished to some extent by means of a non-solvent coating. Such a coating would be deposited much more heavily on the outer surface of the grain than on the inner surface of the perforation. As a result the inner surface of the grain would burn more rapidly than the outer, and would thus yield a progressive powder. The current deterrents, DNT for single-base, and centralite for double-base powders, both gelatinize nitrocellulose.

6. In considering the compounds to be tried as possible higher melting substitutes for DNT, it was decided to include only materials which could be melted down in hot water. The use of higher temperatures would have the disadvantages of greater hazard, some probable decrease in stability of the powder, and probably higher cost. A survey of the literature was made for compounds melting between 85° and 95°C which would also be compatible with nitrocellulose. A number of compounds, which met these requirements, were selected for the coating experiments. In general, the materials were purified by recrystallization before use. See Experimental Procedure. compounds w
The compounds were: -

a. 2,4 dinitroanisole MP 94.3 - 95.1°C
b. N,N'-diethyl-N'-phenylurea MP 84.5 - 85.6°C
c. N-ethyl, N-N' diphenylurea MP 89.2 - 90.1°C
d. meta-terphenyl MP 85.4 - 8[illegible].8°C
e. p,p'-tetraphenyldiaminodiphenylmethane MP 88.0 - 88.5°
f. o-tolyl-alpha-naphthylamine MP 94 - 95°C
g. acenaphthene MP 93.2 - 94.1°C
h. p-tertiary amylphenol 90.0 - 91.0°C

7. The coating of small arms powders is usually carried out in a Sweetie barrel. This is a torus shaped vessel with a circular opening on one side. The Sweetie barrel rotates on a centrally pivoted shaft at a controlled speed. The lower portion of the barrel moves through a hot water bath, or the barrel may be jacketed and steam heated to control the temperature of the powder mixture. A dry or wet mixing method, i.e., with or without the addition of water to the powder, can be used (Ref C and D). At Picatinny Arsenal a small amount of water is usually added to the powder before coating.

8. As a small steam jacketed Sweetie barrel of a size suitable for small scale experimental work was not available, a stainless steel, round-bottomed, steam jacketed, laboratory reaction vessel, provided with an air-driven three-bladed stirrer, was used. This equipment permitted the temperature of the powder-water mixture to be raised to the boiling point of water from room temperature

DISCUSSION OF RESULTS: (contd)

in about two minutes, and the temperature to be maintained within a range of less than $\pm$ 1°C.

9. At first, considerable clustering was encountered. Some experiments resulted in over 60% of clusters. A number of preliminary experiments were then made with 4,6, and 8% of the coating agents, to develop a technique which would give a good coating and a minimum of clustering. The following factors are considered to affect the amount of clustering:

a. Rate and type of stirring - The agitation should be such as to keep each grain in suspension, and moving rapidly enough to keep it from adhering to the walls. The stirrer blades should parallel the curved bottom and produce effective mixing of the powder.

b. Ratio of water to powder - Although this ratio is not critical, about two parts of water to one of powder was found to be most satisfactory. This ratio will probably vary with the design of the kettle and the stirrer.

c. Method of adding the coating - A maximum of clustering was obtained when the entire amount of coating agent was added at one time, either in the cold or after the temperature of the powder-water mixture had been raised above the melting point of the coating agent. The minimum amount of clustering was obtained by raising the temperature of the powder mixture to about 1°C above the melting point of the coating material, and adding the latter in increments at regular intervals. Addition of four increments at 5-minute intervals was established as the standard procedure.

10. Given only traces of clustering, the factors in the coating procedure which affect the ballistics are:

a. Uniformity of coating - This results mainly from efficient agitation.

b. The amount of coating used - This must be sufficient to permit the adjustment of pressure and velocity to the approximate range desired.

c. Time and temperature of mixing the molten coating with the powder-water slurry. These two factors are of prime importance in controlling the extent of gelatinization and therefore the rate of burning. In order to minimize the effect of temperature on the extent of gelatinization, the maximum temperature was held at 1°C above the melting point of the coating agent. Variations in ballistics were then obtained by varying the time of mixing. This can be seen from the effect of coating for 20,40, and 60 minutes with 6% DNA (Table V). The powders coated for 20 and 40 minutes met the ballistic requirements of 2910 $\pm$ 15 ft-seconds and a maximum mean pressure of 53000 psi as given in Specification JAN-P-733 for M20 caliber .50 powder. However, the 60-minute sample was

DISCUSSION OF RESULTS: (contd)

gelatinized too much, so that the burning rate was slowed up sufficiently to make the velocity and pressure too low.

11. No difficulty was experienced in getting 6% or even 8% of the gelatinizing coatings to adhere to the powder by the technique described above. However, the non-gelatinizing agents gave very poor coatings. Only small fractions of the amounts added adhered to the powder grains. In the case of m-terphenyl, the addition of a number of wetting agents to the slurry was tried without satisfactory results. These agents included:

Code No	Chemical Nature	Ionic Class
1	sodium sulpho succinate	anionic
2	condensate of a fatty acid with 2-amino-2 methyl-1,3 pentanediol	cationic
3	aromatic polyglycol ether	non-ionic
4	probably lecithin / soybean oil	non-ionic
5	alkyl aryl sodium sulphonate	anionic
6	pentaerythritol soybean fatty acid monoester	non-ionic

Since satisfactory results were obtained with DNA, no further work was done with the non-gelatinizing compounds.

12. The results of the 100°C Vacuum Stability Test and the 134.5°C Heat Test on the DNA-coated powders in comparison with the standard DNT-coated powders show that the former are at least as stable, see Tables III and VI. Results of the 80°C and 65.5°C tests are still incomplete. These tests have been in progress for 107 days. This length of time at 80°C is definitely anticipatory of a satisfactory 65.5°C Heat Test. A normal 80°C Surveillance Test on caliber .50 DNT-coated powder is 125 to 150 days. Such powders usually give 65.5°C Surveillance Tests of 500 to 600 days.

13. Usually about 9% of DNT is added to caliber .50 powder. This results in about 0.5% less based on the final composition, see Tables III and IV. For this work, it was decided to start with 6% and 8% of added coating material and to coat for 20,40, and 60 minutes. It was hoped that from these preliminary experiments the conditions which would yield the desired ballistics would be indicated. Fortunately, these were obtained with the powders coated with 6% DNA for 20 and 40 minutes. From an examination of the ballistic results with N,N'-diethyl-N-phenylurea and N-ethyl-N-N'-diphenylurea, it appears that the powders had been slowed down too much even with 6% of added coating and 20 minutes' treatment. Undoubtedly, coating conditions could be found which would yield powders with these compounds which would give the desired ballistics.

DISCUSSION OF RESULTS: (contd)

However, both these compounds would be much more expensive to prepare than DNA.

14. Refined 2-4 DNT is currently quoted at $0.21 per pound in drums, or about $0.019 per pound of coated powder. Surplus war time stocks are still being used at Picatinny Arsenal for coating powders. Dinitroanisole is at present produced in this country by only one manufacturer (Code No 7) whose production capacity is less than one ton per week and who operates intermittently. The high cost of keeping such a small plant in operation for intermittent production, plus the absence of competition, is reflected in the current price of $0.85 per pound for a refined grade of DNA. During the third year of World War II, about 180 million pounds of DNT were required for propellants (Ref E). From information furnished by the Inspection Division of Picatinny Arsenal, it is estimated that about 50 million pounds were used for coating small arms powders. Since about two-thirds as much DNA as DNT is needed for coating, about 33 million pounds of the former would be needed to replace the latter. This is more than 300 times the current rate of production of DNA. Based on the estimated emergency smokeless powder requirements given by the Ordnance Ammunition Center (formerly Field Director of Ammunition Plants) about a 50% increase or approximately 50 million pounds of DNA may be needed (Ref F). Some experimental and semi-plant scale work was done by Desvergnes and others in France who reported yields up to 95% of the theoretical by the interaction of 2-4 dinitrochlorobenzene with methyl alcohol in the presence of alkali (Ref G). Dinitrochlorobenzene is currently quoted at about $0.18 per pound and synthetic methyl alcohol at about $0.32 per gallon. Based on a 90% yield of refined DNA, the material cost would be about $0.22 per pound. However, in view of the probable shortages and increasing costs during an emergency, the prices quoted would probably be low. A tentative estimated cost of about $0.40 per pound of DNA seems reasonable. This is equivalent to about $0.024 per pound of smokeless powder.

15. Since DNA would be a new material in propellent compositions, a number of questions regarding its use will arise. Among the questions to be answered may be listed:

a. How pure (MP) does the DNA need to be?

b. What are the normal impurities present and what is their effect on the coating properties, ballistics and stability?

c. How much of each of the impurities shall be permitted?

In short, considerable information will be required so that a satisfactory specification for DNA, for use in coating powders, may be written. To obtain such information, a study of the preparation of DNA first on a laboratory scale and later on a semi-plant scale should be undertaken. Since the services have requested and could use immediately small arms powders coated with higher

DISCUSSION OF RESULTS: (contd)

melting point material than the current standard DNT, it seems advisable, even on the basis of the preliminary results obtained to date, to expedite the work suggested above.

EXPERIMENTAL PROCEDURE:

16. Materials:

a. 2,4 Dinitroanisole. Eastman Kodak Company red label grade was recrystallized from alcohol. The melting point of the product was 94.3 - 95.1°C.

b. N,N'-diethyl-N'-phenylurea was synthesized according to the method of Berichte 17 3039 (1884). This involved the interaction of phenyl-isocyanate and diethylamine. The reaction product was recrystallized from alcohol to yield material melting at 84.5 - 85.6°C.

c. N-ethyl, N-N' diphenylurea (monoethylcentralite, or N-ethyl-carbanilide) was prepared by the interaction of phenylisocyanate and monoethyl-aniline according to the method of Berichte 17 2093 (1884). The reaction product was recrystallized from alcchol to yield material melting at 89.2 - 90.1°C.

d. Meta-terphenyl (m-diphenylbenzene) from Monsanto Chemical Company, melting point 85.4 - 85.8°C.

e. p,p' - Tetraphenyldiaminodiphenylmethane from Eastman Kodak Company, melting point 88.0 - 88.5°C.

f. o-tolyl-alpha-naphthylamine MP 93.2 - 94.1°C.

g. acenaphthene MP 93.2 - 94.1°C.

h. p-tertiary-amylphenol 90.0 - 91.0°C.

i. Caliber .50 type I rifle powder PA Exp Lot 3292. This powder was prepared according to standard procedure and left uncoated for experimental work. It was prepared in accordance with the composition and granulation shown in Table I. When coated with DNT in the standard manner such powder normally complied with the requirements of Specification JAN-P-733 for Type I, Caliber .50 powder for use in the API-M8 projectile.

j. A standard lot of caliber .50 powder, duPont Lot 27922, was used to calibrate the test rifle, and as a basis of comparison with the experimental powders. The characteristics of this powder are given in Table II.

EXPERIMENTAL PROCEDURE: (contd)

17. Equipment:

A number of attempts were made to coat caliber .50 powder in small Sweetie barrels at the Experimental Propellant Plant. It was not found possible to maintain the mixture at the desired temperature, 96 - 97°C, although live steam was run directly into the slurry of powder and water. Satisfactory temperature control and stirring were obtained with a stainless steel, round bottom, steam jacketed, laboratory kettle, provided with an efficient air stirrer. The capacity of the kettle was 2650 ml to the top of the jacket. The three blades of the stirrer were curved to the contour of the bottom and were set at an angle of 45° so that their motion served to throw the powder grains upward and away from the bottom. All the coating reported was done in this kettle.

18. Coating Procedure

After a number of preliminary experiments to determine the conditions which would give a good coating with a minimum of clustering, the following procedure was used for 2,4 dinitroanisole, N,N'-diethyl-N-phenylurea, and N-ethyl-N,N -diphenylurea which are gelatinizing agents for nitrocellulose.

19. One liter of water and 500 grams of uncoated powder were added to the kettle and the mixture well stirred so that each grain of powder was kept moving in suspension in the water. Steam was turned on and the temperature raised to and maintained at 1° to 2°C above the melting point of the coating agent. As soon as this temperature was reached, which was usually in approximately 2 minutes, one-fourth of the weight of the coating agent (30 or 40 grams for 6 and 8% respectively) was added and at 5-minute intervals the remaining three-fourths. Heating and stirring were continued for 5, 25, or 45 additional minutes to give total heating periods from the time of the first addition of 20, 40, and 60 minutes. At the end of the desired heating time the steam was turned off and the mixture allowed to cool spontaneously while stirring. When the temperature had dropped to below 50°C the kettle was emptied and the powder separated by filtration. Suction was continued until the powder was nearly dry and then transferred to a paper tray and air-dried. The powder was then screened through 12- and 30-mesh screens. Clusters were retained on the 12-mesh screens and fines or coating material which did not adhere to the powder passed through the 30-mesh screen. Each portion was weighed and recorded.

20. With the non-gelatinizing coating agents, m-terphenyl and p-p' tetramethyldiaminodiphenylmethane, etc, the same procedure was followed as with the other coating agents. When poor coating was obtained a number of experiments were made with the addition of various wetting agents which might possibly improve the coating. Satisfactory coatings were not obtained with the non-gelatinizing materials.

EXPERIMENTAL PROCEDURE: (contd)

21. The screened batches of well-coated powders were then glazed with graphite at the Experimental Propellant Plant, the external moisture content adjusted to about 1% and the powders subjected to ballistic tests in a standard caliber .50 rifle. The data obtained are given in Table III together with similar tests on a standard reference powder. Analytical and stability data on the DNT-coated, reference powder and on the 6% and 8% dinitroanisole-coated powders are given in Tables III, IV and VI.

REFERENCES:

A. MCREXG61: JFC: luw, 0.0. 471.91/1(c)
Points out the need for deterrent coatings which will stand temperatures of 200°F (93°C).

B. 0.0. 471.91/14(c) dated 7 March 1950
Directive from Ordnance Office to find a higher melting substitute for DNT as a deterrent coating.

C. duPont Smokeless Powder Manual. v. II pp 8400 et seg. Gives details of the coating cycle.

D. RD 12 (Winer) - Hercules Powder Company, Radford, Virginia October 1, 1945. Research reports on coating of small arms powders.

E. "Supply Problems in Propellant Ingredients" by A. C. Scurlock. Bulletin of Seventh Meeting of the Joint Army-Navy-Air Force Solid Propellants Group. April 16-18, 1951, Table III page 21.

F. "Supply Problems in Nitrocellulose" by D. R. Cameron. Bulletin of the Seventh Meeting of the Joint Army-Navy-Air Force Solid Propellants Group. April 16-18, 1951. Table III page 12.

G. "Trinitroanisole and Trinitrophenetole" by L. Desvergnes. Memorial des Poudres 19 273 and 274 (1922).
Includes the preparation and properties of DNA with references to previous work.

INCLOSURES:

Tables I - VI

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TABLE I

FORMULATION AND GRANULATION OF CALIBER .50
SMOKELESS POWDER EXPERIMENT NO 3292
USED FOR COATING EXPERIMENTS

Nitrocellulose (13.15%N) - cotton linters	100.00%
Potassium Sulfate added	1.00%
Diphenylamine added	0.75%
Solvent (2E-1A)	94.00%
Average Web (dry)	0.0222 inch
Die Diameter	0.0830 inch
Pin Diameter	0.0210 inch
Length of Grain (green)	0.099 inch

TABLE II

COATING OF CALIBER .50 POWDER PA LOT 3292 [1]

Coating Compound	Coating [2] Added %	Total time of Coating min [3]	Temp °C	Clusters %	Remarks
2-4 Dinitroanisole	6	20	96 ± 1°	trace	slight residual DNA
		40		0.09	slight residual DNA
		60		0.07	slight residual DNA
	8	20		0.19	slight residual DNA
		40		0.37	slight residual DNA
		60		0.29	slight residual DNA
N,N'-diethyl-N-phenylurea	6	20	87° ± 1°	1.3	coatings complete except with short coating time
		40		1.1	
		60		0.36	
	8	20		1.9	
		40		4.4	
		60		2.5	
N-ethyl-N,N'-diphenylurea	6	20	91° ± 1°	0.36	coatings clean no residual coating material
		40		1.4	
		60		0.98	
	8	20		0.04	
		40		0.07	
		60		0.72	

1 - 500g of powder plus 1000 ml of water heated to temperature

2 - Coating added in 4 increments at 5-minute intervals

3 - Time from addition of first increment to shutting off steam

TABLE III

DATA ON U. S. ARMY LOT 27922 OF 1944*

Manufacturer - E. I. duPont de Nemours and Company, Inc

Place of Manufacture - Carney's Point, New Jersey

Nitrocellulose -	
Nitrogen Content, %	13.16
KI Starch Test (65.5°C) min	45+
Stability Test (134.5°C Test) min	30
Composition (Inspectors Analysis)	
N/C, %	90.48
K_2SO_4, %	0.62
DNT, %	8.28
Diphenylamine, %	0.62
Total Volatiles, %	1.64
Moisture, %	0.99
134.5°C Heat Test - Salmon Pink (min)	45
Explosion (hours)	5+
Gravimetric Density	.954
Grain Dimensions (Finished Grain)	
Length, inches	0.0850
Diameter, inches	0.0553
Diameter of Perforation, inches	0.0109
Web average, inches	0.0222

* Taken from Description Sheet dated 3/31/44

TABLE IV

DATA ON PA EXPERIMENTAL LOT 3292 COATED WITH DNA

	6% DNA, coated 20 min		6% DNA, coated 40 min	
Composition:				
Diphenylamine, %	0.91		0.92	
Potassium Sulfate, %	1.02		1.01	
Graphite, %	0.32		0.31	
DNA, %	5.50		5.50	
NC (by diff.), %	92.25		92.26	
Total	100.00		100.00	
Total Volatiles, %	1.11		1.14	
External Moisture, %	0.80		0.94	
Hygroscopicity Value, %	1.64		1.63	
Measurements:				
Length of Grain (L) inches, avg	0.0887	Var. 3.38%	.0894	Var. 4.10%
Diameter of Grain (D) inches, avg	0.0544	Var. 1.78%	.0549	Var. 1.40%
Diameter of Perforation (d) inches, avg	0.0104		.0107	
Web (W_a)	0.0220		.0221	
Web calculated (W_c)	0.0220		.0221	
Ratio L:D	1.63		1.63	
D:d	5.23		5.13	

Table V

Ballistic Results on Caliber .50 Coated Powders (1)

Powder Lot No and Coating Compound	Coating Added %	Total Coating Time min	Charge wt grains	Muzzle Velocity Mean ft/sec	Muzzle Velocity Max Var ft/sec	Muzzle Velocity Max Var %	Muzzle Velocity Mean Var ft/sec	Pressure Mean lbs/sq in	Pressure Max Var lbs/sq in	Pressure Max Var %	Pressure Mean Var %	Pressure Max lbs/sq in	Air Space in	Flash Size	Flash Color	Remarks
27922 (Standard) DNT	9		234	2919	26	0.9	5.9	48,800	3000	6.15	1.5	50,000	0.3	1x6	orange	Velocity and pressure data average of 10 rounds.
Exp 3292 2,4 Dinitroanisole	6	20	224	2916	30	1.03	9.2	48,400	3000	6.20	1.30	49,200	0.2	3/4 std	orange	Velocity and pressure data average of 10 rounds. Flash intensity equal to standard.
	6	40	223	2931	38	1.3	2.9	49,100	4400	9.0	2.17	52,200	0.2			Velocity and pressure data average of 10 rounds. Flash intensity equal to standard.
	6	60	237	2873				46,800					none(2)			Velocity and pressure too low with full case.
	8	20	225	2537				33,600					none			Velocity and pressure too low with full case.
	8	40	225	2684				38,400					none			Velocity and pressure too low with full case.
	8	50	232	2890				45,200					none			Velocity and pressure too low with full case.
Exp 3292 N,N'-Diethyl-N-phenylurea	6	20	225	2615				35,600					none			Velocity and pressure too low with full case.
	6	40	225	2702				38,200					none			Velocity and pressure too low with full case.
	6	60	225	2644				36,000					none			Velocity and pressure too low with full case.
	8	20	225	2277				24,600					none			Velocity and pressure too low with full case.
	8	40	225	2267				22,800					none			Velocity and pressure too low with full case.
	8	60	210	2024				17,600					none			Velocity and pressure too low with full case.
Exp 3292 N'-ethyl-N,N'-diphenylurea	6	20	225	2427				31,000					none			Velocity and pressure too low with full case.
	6	40	225	2427				29,200					none			Velocity and pressure too low with full case.
	6	60	227	2395				27,800					none			Velocity and pressure too low with full case.
	8	20	225	2444				23,800					none			Velocity and pressure too low with full case.
	8	40	225	2141				19,800					none			Velocity and pressure too low with full case.
	8	60	225	2352				25,600					none			Velocity and pressure too low with full case.

(1) Specification Requirements-JAN-P-733 Muzzle Velocity 2910 ± 15 f/s Standard Deviation 40 f/s Extreme Variation 100 f/s
Maximum Mean Pressure 53,000 psi

(2) Case capacity

TABLE VI

STABILITY TESTS ON STANDARD AND EXPERIMENTALLY COATED POWDERS

	duPont Lot 27922, Standard DNT	Experimental Lot 3292 coated with DNA for 20 min	Experimental Lot 3292 coated with DNA for 40 min
100°C Vac Stab, cc gas in 40 hrs	2.87	1.25	1.46
134.5°C Heat Test			
Salmon Pink, min	40	50	45
Ref Fumes, min	45	50	50
Explosion in 5 hours	none	none	none
80°C Surveillance Test, days started 5/15/51			
65.5°C Surveillance Test, days started 5/15/51			

CODE SHEET

Code No	Trade Name	Manufacturer
1	Aerosol OT	American Cyanamid and Chemical Corporation
2	Alkaterge C	Commercial Solvents Corporation
3	Neutronyx 600	Onyx Oil and Chemical Company
4	Yelkin TT	American Lecithin Company
5	Nacconol NR	(National Aniline Division) Allied Chemical and Dye Corporation
6	Pentamull 87	Heyden Chemical Corporation
7	— —	Verona Chemical Company, Newark, NJ